Ultrasound imaging for the rheumatologist XXXII. Sonographic assessment of the foot in patients with psoriatic arthritis

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ABSTRACT

Psoriatic arthritis (PsA) is an arthropathy associated with psoriasis, which is part of the spondyloarthropathy family, and which may present with various forms, from mono-oligoarthritis to symmetric polyarthritis mimicking rheumatoid arthritis. In longstanding disease, the symmetric polyarthritis is the most common pattern of PsA, involving the small joints of hands, feet (the involvement of which seems to be very common, ranging from 50 to 100% of patients), wrists, ankles and knees. Other common features are represented by the inflammation of enthesis and tendons. Its exact prevalence, in Italy, should be about 30% in psoriatic subjects or 0.42% when considering the general population. The aims of our study were to investigate, by US examination, the prevalence and the features of foot involvement in PsA and to describe their correlations with clinical findings. Ultrasound (US) examinations were performed using a Logiq 9 (General Electric Medical Systems, Milwaukee, WI) equipped with a multifrequency linear probe, working at 14 MHz. One hundred and eighty feet were investigated in a total of 101 patients. Prior to US assessment, all patients underwent a clinical examination by an expert rheumatologist who recorded the presence/absence of pain, tenderness (detected by palpation and/or active or passive mobilisation of the feet) and swelling. US finding indicative of metatarsophalangeal joint inflammation were obtained in 77 (76.2%) patients, while only 34 (33.7%) patients were positive to the clinical examination. This study demonstrates that US detected a higher number of inflamed joints with respect to clinical assessment in PsA patients.

Introduction

Psoriatic arthritis (PsA) is an inflammatory joint disease associated with psoriasis, classified into the family of spondyloarthropathies; its exact prevalence is still debated but, looking at the literature, in Italy it should be about 30% in psoriatic subjects (1-4) or 0.42% when considering the general population (5). PsA is characterised by a great variability in clinical features and severity, ranging from mono-oligoarthritis to symmetric polyarthritis mimicking rheumatoid arthritis (RA), with benign or seriously destructive disease (the so-called mutilans arthritis). Symmetric polyarthritis has been demonstrated to be the most common pattern of PsA in longstanding disease, involving primarily the small peripheral joints (hands, feet, wrists, ankles) and the involvement of the feet seems to be very common, ranging from 50 to 100% of the patients (6, 7). Recently, has also been demonstrated that, in the feet, the presence of disease activity was associated with subsequent damage, in particular in the same toe (8). Entheses and tendon involvement are characteristic features of the spondyloarthritides, probably most prominent in PsA, where plantar fascia and Achilles tendons are more frequently affected. Moderate-to-high levels of foot-related impairment and disability are frequent in PsA patients, but only 20% of them receive foot care (9). Moreover, subclinical involvement has been demonstrated using MRI, also in subjects affected only by psoriasis (10, 11). Due to all of the previous data, a

full exam of the feet appears to be recommended.

Musculoskeletal ultrasound (US) is a technique that has become increasingly used in rheumatologic practice. Although it provides a greater sensitivity than clinical examination in the detection of synovitis, enthesitis and tenosynovitis in most of the rheumatic diseases (12-22), and even if foot involvement is quite common in PsA, to date, only few studies have evaluated foot involvement in PsA using this technique (20-24).

The aims of our study were to investigate, by US examination, the prevalence and the features of foot involvement in PsA and to describe their correlations with clinical findings.

Methods

We performed a multicentre study in 4 different Rheumatology Units in Italy (University of Pisa, University of Pavia, Università Politecnica delle Marche and the Sapienza University of Rome). In each unit, US examinations were performed by a rheumatologist experienced in musculoskeletal US using a Logiq 9 (General Electrics Medical Systems, Milwaukee, WI), with a linear probe operating at 14 MHz. Good-to-excellent inter-observer agreement rates were previously found (19, 25) in the detection and semiquantitative assessment of US signs of joint and entheseal inflammation and bone erosion. The study was conducted according to the Declaration of Helsinki and local regulations, and informed consent was obtained from all patients.

Patients

One hundred and one patients with PsA, either out-patients or in-patients, were consecutively enrolled in the study, independently of disease duration and extent of clinical signs of feet involvement. The diagnosis of PsA was established according to the CASPAR criteria (26). Exclusion criteria included history of severe trauma or surgery of the foot. Demographic and clinical characteristics of the study population are reported in Table I. Bilateral examination of the feet was performed in 79 patients, while monolateral was done in 22 subjects (due to various causes, *i.e.* presence of other localised diseases).

Table I. Demographic and clinical data.

Number of patients	101
Gender (female/male)	57/44
Age in years (median ± SD; range)	50.8±12.5; 18-75
Disease duration in months (median ± SD; range)	53.4±33.2; 2-281
Rheumatoid factor positive (no. of patients)	4
ACPA positive (no. of patients)	1

SD: standard deviation.

Table II. Scanning technique adopted for the study.

Scanning planes	Position of the patient	Anatomic structures under examination
Dorsal transverse and longitudinal scans	Patient in supine position with the foot in neutral extended position and with the knee semiflexed at 30°	Midfoot, MTP and PIP joints Tibialis anterior, extensor hallucis, and common extensor tendons
Volar transverse and longitudinal scans	Patient in prone position with the feet standing out from the couch in neutral position	MTP joints, flexor tendons and plantar fascia
Medial and lateral transverse and longitudinal scans	Patient in supine position with the foot in neutral extended position and with the knee semiflexed at 30°	1st and 5th MTP (respectively) to assess erosions
Lateral longitudinal and transverse scans	Patient in supine position with the foot in neutral extended position and with the knee semiflexed at 30°	Peroneus longus and brevis tendons, calcaneo-cuboid and cuboid-5th metatarsal joints

Study design

Prior to US assessment, all the patients underwent a clinical examination by an expert rheumatologist who recorded the presence/absence of pain, tenderness (by palpation and/or active or passive mobilisation of the foot), and foot swelling at the joint level. Because of the great difficulty in distinguishing between the single joints of the midfoot, while performing the clinical examination, we decided to analyse that region as if it were a single joint.

All US examinations were performed by experienced sonographers, one for each centre involved in the study, who were blind to both the clinical and laboratory data.

US scanning technique

A US multiplanar examination was performed according to the EULAR guidelines for musculoskeletal ultrasound in rheumatology (27). All views were obtained with the feet in a neutral position. Sonographic measurements of entheses thickness were performed where it appeared maximum. A detailed description of the scans adopted is reported in Table II.

The setting parameters were standardised as follows:

- grey scale gain was initially set in order to obtain the maximal contrast between the different tissues under examination, and successively reduced to the lowest level allowing the visualisation of only hyperechoic structures using the bony cortex as reference;
- pulse repetition frequency of 500 Hz, Doppler frequency of 7.5 MHz and Doppler gain to avoid random noise visualisation.

US image interpretation

Joint effusion, synovial hypertrophy, and bone erosion were registered by US according to the preliminary definitions provided by the Outcome Measures in Rheumatoid Arthritis Clinical Trials (OMERACT) Special Interest

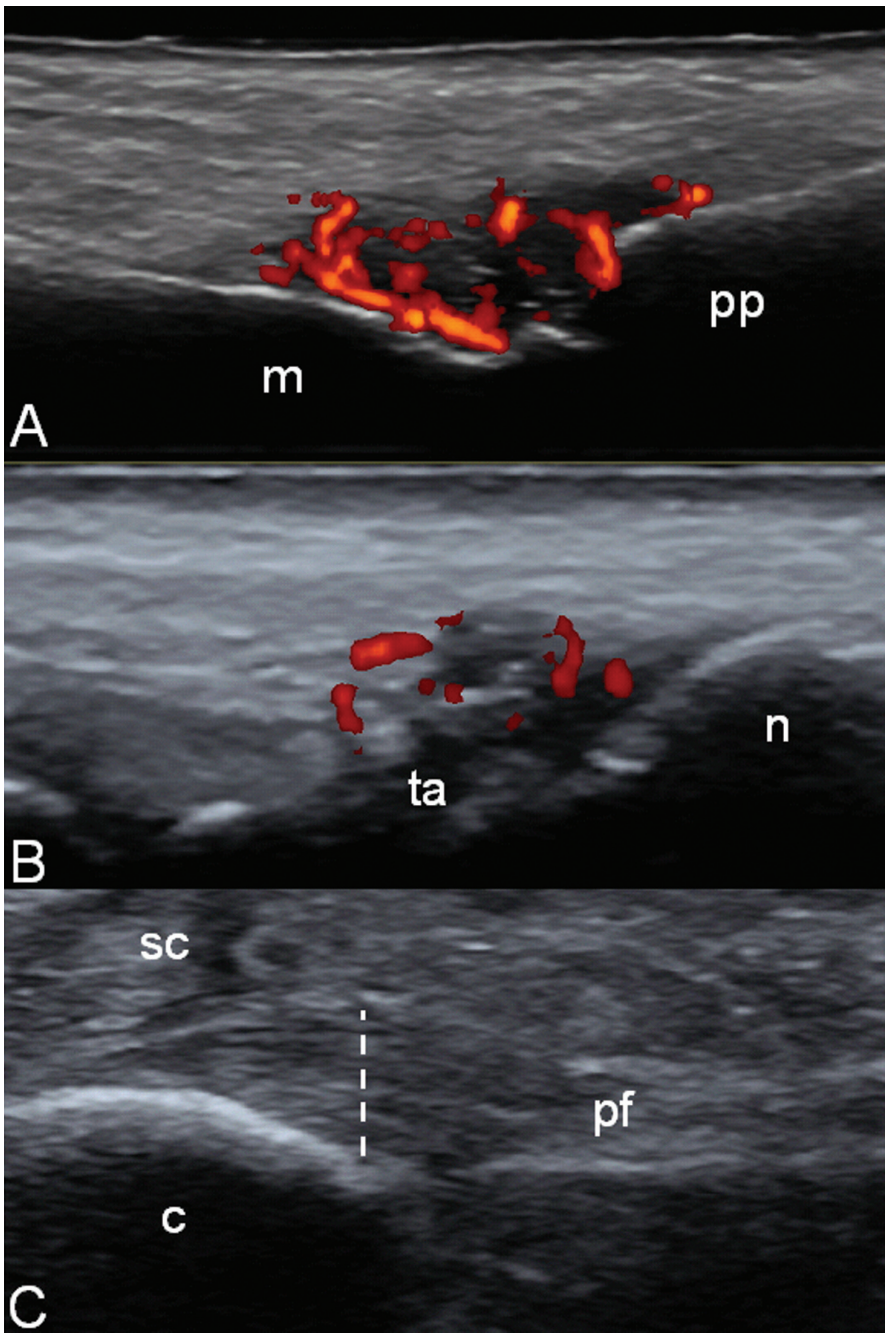

Fig. 1. Psoriatic arthritis. Foot. **A**. Synovitis of the second metatarsophalangeal joint in longitudinal dorsal scan. Evident joint cavity widening due to synovial hypertrophy showing intense power Doppler signal. **B**. Synovitis of the talo-navicular joint in longitudinal dorsal scan showing mild joint cavity widening with mild intra-articular power Doppler signal. **C**. Plantar fasciitis in longitudinal plantar scan. The image shows the fusiform swelling of the plantar fascia. The vertical white line indicates where thickness measurement (6 mm) was taken. **m**: metatarsal bone; **pp**: proximal phalanx; **ta**: talar bone; **n**: navicular bone; **c**: calcaneal bone; **pf**: plantar fascia; **sc**: subcutaneous tissue.

Group for Musculoskeletal Ultrasound in Rheumatology (28). We considered the fibrous sheath of the flexor tendons of the foot finger as a real sheath, calling its inflammation as a tenosynovitis. Enthesitis was defined as hypoechogenicity and/or thickening of the entheses, as well as the presence of power Doppler signal at the entheseal level (29); plantar fascia proximal insertion has been considered as an enthesis.

Because of the study design (not assessing the presence of hallux valgus, frequently associated to erosions of the medial part of the 1st MT head), we decided to consider as a real erosion of the 1st MTP only those situated on the dorsal aspect.

Cartilage evaluation was performed using the well known morphostructural changes to detect the presence of monosodium urate (MSU) or of calcium pyrophosphate dihydrate (CPPD) crystal deposits (the hyperechoic enhancement of the superficial margin and the hyperechoic spots within the cartilage layer, respectively) (30).

Results

Twenty joints were evaluated by US in each foot, for a total of 3600 joints. The prevalence of synovitis in the single joints is reported in Table III.

Joint

One hundred and eighty feet were investigated in a total of 101 patients. Clinical examination found signs suggestive of articular inflammation in 25 feet (19 patients) at the midfoot region and at 117 MTP joints (34 patients) while, by US, were visualised in 39 feet (29 patients), at the midfoot region, and 260 MTP joints (77 patients), respectively. As reported in Table III, MTP 1st to 3rd are the most involved joints in the foot when considering synovitis. The volar scans of the MTP did not provide any useful information, in fact it showed synovitis only in 4 joints from the same patients, which were also visible in the dorsal scan also. Table IV reports the findings obtained by clinical examination and US assessment of the feet joint. The concordance between clinical examination and US was good in the negative US group (93% and 92% at midfoot and MTP level, respectively), while poor in the positive US group (38% and 25% at midfoot and MTP level, respectively). US findings related to inflammation were found in 324 joints (9% of total) in 83 patients (82.2%).

In the 114 feet defined as inflamed by US, effusion was always found, while synovial hypertrophy with or without intra-articular power Doppler signal was detected with a lower prevalence (42.8%) of the feet, out of 57 patients (56.4%).

Bone erosions were imaged in 35 feet (from 27 patients), localised mostly at

the MTP level (structural damage was present in 4.5% of the MTP). We detected erosions in 49 joints, localised in the talo-navicular, navicular-cuneiform, 1st MTP, (both on the dorsal and medial surface), 2nd to 5th MTP (concerning the 5th MTP only at the lateral side), 4th and 5th PIP and calcaneal bone (see Table III for exact prevalence). No erosions were noted on the volar aspect of the MTP, except for a single patient who presented bilateral erosion of the head of 3rd and 4th metacarpal bone, and in 2 calcaneal bone (Table III). The most involved joint was the 1st MTP with bone erosions of the dorsal aspect in 16 feet, and of the medial side in 19 feet (but in 13 cases they were localised only at this level).

Tendons

US revealed tenosynovitis in a minority of feet: only 37 (2%) tendons were considered inflamed, and in 5 patients it was bilateral. Only 4 out of 37 tendons showed a proliferative tenosynovitis, with associated positive power Doppler. The inflamed tendons were the common extensor (in 12 feet), the flexor (12 in 8 feet), the extensor hallucis (in 5 feet), the peroneus longus and brevis (in 4 feet, each). No tendon tears were imaged.

Entheses

Findings of enthesitis were almost all detected in the plantar fascia (18 enthesitis in 13 patients). In fact a power Doppler signal was detected in the posterior tibialis enthesis only in 1 patient. None of the plantar fasciitis showed power Doppler signal. Enthesophytes were also found in 25 sites (1 tibialis anterior and 24 plantar fascia), bilaterally in 9 patients.

Other findings

Besides findings related to joint synovitis and tendon or entheses involvement, we recorded the typical "double line" pattern (hyperechoic line at the upper part of the cartilage layer) in the feet of two patients (monolaterally), suggestive of the presence of an MSU crystal deposition, while intrarticular hyperechoic spots were noted in a joint from one individual patient.

Table III. Prevalence of joints synovitis, PD positivity and erosions.

Joint	Synovitis (n. of feet)	PD positivity (n. of feet)	Erosions (n. of feet)
Talo-navicular	23	10	7
Navicular-cuneiform	14	6	2
Calcaneous-cuboid	7	2	0
Midtarsal	9	2	0
1st MTP	72	9	16 (dorsal) 19 (medial)
2nd MTP	77	12	3
3rd MTP	52	12	0
4th MTP	41	8	0
5th MTP	18	7	7 (lateral)
1st IP	6	0	0
2nd PIP	4	2	0
3rd PIP	1	1	0
4th PIP	0	0	2
5th PIP	0	0	2

Table IV. Comparison between sonographic and clinical findings indicative of foot joint inflammation obtained in a total of 101 patients with PsA.

		Clinical findings		
	US findings	Presence (n. of feet)	Absence (n. of feet)	Total
Midfoot region	Presence (no. of feet)	15	24	39
	Absence (no. of feet)	10	131	141
Total	(no. of feet)	25	155	180
		Presence (n. of MTP joints)	Absence (n. of MTP joints)	
MTP	Presence (no. of MTP joints)	66	194	260
	Absence (no. of MTP joints)	51	589	640
Total		117	783	900

Discussion

PsA has been associated with moderate-to-high levels of foot-related impairment and disability, therefore requiring the attention of the clinics, especially because only 1 in 5 patients receive foot care (9) and insufficient attention is given to the forefoot during physical examination (7). Even if deformity, joint swelling and tenderness may be milder in PsA than in RA, as for the structural damage (31), the role of other factors (*i.e.* enthesitis, skin and nail psoriasis) could be relevant in the determining disability (32).

To date, few studies have been reported in the literature on the applications of US in the assessment of joint, tendon and entheseal involvement in the course of PsA. In particular, only few investigators have pointed their attention to the features of foot inflammation in such a disorder (7, 20, 23, 24) so, no data are available on its involvement in large PsA population. Moreover, no papers have fully explored articular and periarticular structures. In a few other papers MRI was used (24, 33) but, once again, they were only partial in the structures assessed.

We can divide previous published data into two distinct fields: joint and entheses findings.

Wiell *et al*. (20), studied 15 PsA patients using US, MRI, x-ray and clinical examination, focusing on hands

and feet. At the foot level, they examined only MTP 1st to 5th, finding a high frequency of synovitis (43% and 34% in the PsA and healthy control group, respectively), higher than our (28.8%), with erosion in 15% of PsA MTP (but also in 6% of the healthy control subjects), while we found bone destructive changes only in 4.5% of the MTP. The higher prevalence of synovitis in Wiell's paper could be partly caused by asymptomatic osteoarthritis, as reported by the authors, while we excluded from the total count all joints with significant osteoarthritis bone changes. We should note that a high prevalence of medial erosion of the first MTP are present in hallux valgus pathology, so, if we do not count them, our prevalence of erosion, in MTP joints, becomes lower (2.9%). Differences could be related primarily to the size of the patient sample studied (101 vs. 15), while the different mean disease (3 years in the Wiell study, 4.6 years in our population) could be less important. Finally, the quantity of intra-articular fluid considered "normal" in healthy MTP is not standardised because the mechanical stress on those joints is very frequent and thus a different interpretation of this pathologic finding may explain this discrepancy.

An interesting paper has been produced by Weiner *et al*. (24) who studied 13 PsA patients using, once again, multiple imaging techniques, but, unfortunately, data on synovitis, erosions and bone proliferations from hands and feet are provided together without differentiating per anatomic sites, so we cannot compare them to ours.

Moving from US to MRI, Ghanem *et al*. (33) found MTP joint involvement in 10/12 patients with symptomatic foot (for a total count of 19 MTP), showing a higher prevalence of inflammation in those joints with respect to ours, but, even if theoretically interesting, the selection of the patients (only symptomatic in Ghanem's study) and most of all, the different sensitivity of the technique used [lower for US, as previously demonstrated (20, 24)], makes it impossible to compare the studies.

Regarding the tendons and the entheses, while there is a wealth of literature for the Achilles tendon, foot involvement is almost unknown. In fact, to the best of our knowledge, only a few Authors have examined PsA patients (20, 22, 34). Borman *et al*. (34) evaluated entheseal involvement in the foot using US in 44 subjects with SpA (5 with PsA) and pathological findings were disclosed in 25 patients, most of whom did not complain of foot symptoms. Balint *et al*. (22), compared US with clinical examination in the detection of entheseal abnormalities of the lower limbs in 35 patients with SpA (only 7 with PsA), examining five entheseal sites (including plantar fascia insertion to the calcaneal bone) and detecting increased thickness, bony erosion, and enthesophytes in 35, 6 and 4 cases, respectively.

Unfortunately, in both the studies, findings were reported for the whole SpA group and not for each disease, as in the paper by Gibbon (35) (where plantar fascia enthesis was compared in different diseases).

In the other paper, Falsetti *et al*. (23) studied calcaneal entheses in a mixed group of patients, including 125 PsA subjects: plantar fasciitis was found in 37% of them and enthesophytes in 49%. The differences between those and our results are striking (we reported only 10% of prevalence for plantar fasciitis and 13.3% for enthesophytes) and difficult to understand.

Interestingly, we have found a low prevalence of tenosynovitis (2%) and enthesitis was almost absent (only 19 cases, but 18 localised in the plantar fascia). This unexpected data, if considering that enthesitis represents a hallmark of spondyloarthropathies, could be partly due to technical causes (*i.e*. the relatively small dimension of the entheses in the foot, difficulty to study them due to the anatomical position and, perhaps, lower sensitivity of power Doppler, especially for flexor tendon entheses and plantar fascia, positioned deeply in the plantar side of the foot) and to the relatively active disease. Moreover, the presence of enthesophytes (which may represent the end stage of inflammation or may relate to other pathologic conditions such as trauma or degenerative changes, which are common in the general population) at the calcaneal insertion of the fascia, could also hypothesize, in some cases, a traumatic/degenerative cause for the plantar fasciitis instead of a real inflammatory condition (according to this hypothesis, we found only 2 calcaneal erosions in our patients).

Finally, the paper by Erdem *et al*. (11) reported a high prevalence of foot synovitis in asymptomatic psoriatic patients (46% from 26 patients) with lower prevalence of tenosynovitis and erosions (19% and 4%, respectively). The latter study stresses the importance of a full examination in PsA patients because asymptomatic inflammation is present even in patients with only evident cutaneous disease.

Our results support the higher sensitivity of US rather than clinical examination in the detection of joint inflammation at foot level in patients with PsA. The real concordance regarding clinical examination and US in the midfoot region is by no means easy to do, because the exact distinction of the single joints by palpation alone is very difficult, and that is the reason why we decided to consider all of them as a single one, in the analysis of the results.

Interestingly, the concordance between clinical examination and US is rather low even on the MTP joints, showing that pain at that level might not be related to inflammation and, at the same time, that a low grade inflammation is frequently asymptomatic.

Since we did not use a gold standard imaging technique for the detection of synovitis, possible explanations of the lack of agreement between clinical and US data also include an incorrect interpretation of either clinical or US findings.

Finally, we noticed a low number of patients with intra-articular power Doppler signal. This could be due to the enrollment in the study of also asymptomatic patients (31 of them were negative at the clinical examination).

In conclusion, the present study provides evidence in favour of the higher sensitivity of US in the detection of foot joint inflammation with respect to clinical assessment. Tendon and entheseal involvement is minimal in our patients and only plantar fascia enthesis should be examined.

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